Instruction and Maintenance Manual

RADIOLOGICAL SURVEY METER

OCDM Item No. CD V-720, Model No. 3A

Manufactured 1961

THE VICTOREEN INSTRUMENT COMPANY
5806 Hough Avenue • Cleveland 3, Ohio

This insert was in the original manual. R8 in my unit is 100 kΩ.

RESISTOR R8 SHOULD READ 100 K

o the paper manual ends on page 16 (pdf p. 14).
o after that are pages created as I diagnosed my unit, which is reading high on all ranges.
o I could not locate a service manual for the 720 3a so tried to pattern my supplemental documentation after the repair manual for the 717 1 (https://archive.org/details/cdv-717-1-victoreen).

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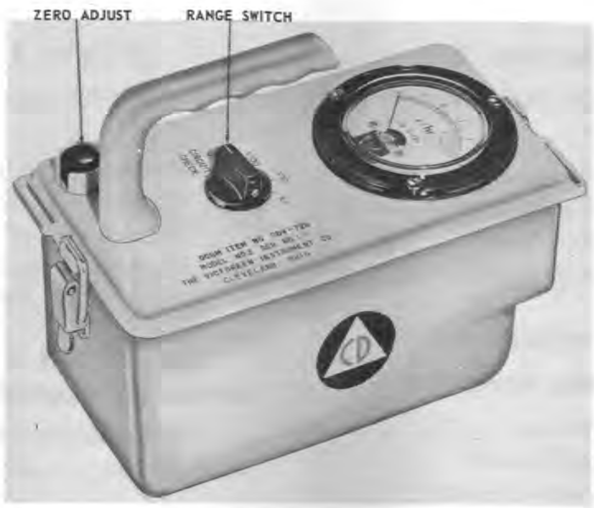


Figure 1. View of CD V-720, Showing Operating Controls

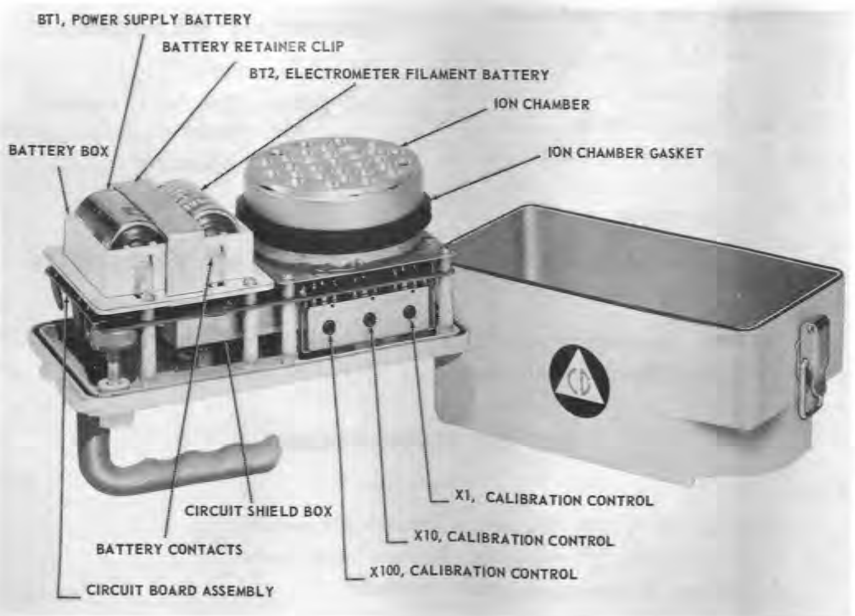


Figure 2. View of CD V-720, Showing Major Components

I measured my DMMs. All are acceptable for measuring the VX-86 filament but lowest currents are Fluke 116, 117, or 3000FC with max current of 0.6mA into 100Ω (1.7mA into 36Ω). Into 100Ω, Fluke 87V MAX is 1.0mA; Fluke 289, 2.0mA; Keysight U1461A, 1.5mA. Auto ranging is OK on these meters (all default to 600Ω range except the 289, which defaults to 500Ω range). Current decreases as range increases so higher ranges, which are not needed for the filament, incur no risk of damage if the RANGE button is pressed. And max voltage varies from 0.06V (Fluke 116, 117, 3000FC) to 0.20V (Fluke 289). And voltage also decreases as range increases. So these DMM's voltage offer no risk to the 1.5V filament. YMMV

1. PRECAUTIONS

1.1 HIGH IMPEDANCE CIRCUITRY:

The "Hi-Meg" resistors, electrometer tube, ceramic switch-wafer, and chamber feed-thru and guard-ring comprise the high impedance circuitry of the CD V-720. Any accumulation of dirt or grease on these parts will contribute to leakage currents that will cause upscale readings which will be most evident on the X1 range. Therefore, it is desirable that these parts be handled as little as possible. These parts may be cleaned with a good quality solvent such as alcohol applied with a soft brush. The solvent should be free of any impurities or contaminants which might leave a residual film as the solvent evaporates.

1.2 SEMI-CONDUCTOR COMPONENTS (DIODES AND TRANSISTORS):

The semi-conductor components used in the CD V-720 may be damaged by prolonged exposure to excessive heat. When replacing any of these components the soldering operations should be accomplished as quickly as possible. Holding the lead between the component and the soldering point with a pair of pliers will decrease the heat transmitted to the component during the soldering operation.

1.3 CHAMBER WINDOW:

The window of the chamber is a thin (0.006 in.) aluminum disc. Although this window is normally quite rugged, caution should be used in measuring contamination on very rough surfaces. If this window should be punctured the hermetic seal of the chamber is destroyed and the readings are no longer independent of altitude, temperature, and humidity.

1.4 ELECTROMETER TUBE:

When checking for a possible open filament of the electrometer tube, be certain to use an ohmmeter which has an output current of less than 10 ma. For example, a Simpson Multimeter on Range RX1 will deliver approximately 125 ma and will burn out the filament of the electrometer tube if used to measure the filament resistance on that range.

2. GENERAL DESCRIPTION

2.1 INTRODUCTION:

The CD V-720, Model 3A, Victoreen Model 720C, is a portable monitoring instrument which measures gamma radiation dose rates as high as 500 roentgens per hour and in addition can detect beta radiation from fission products. It is designed to be used by radiological Civil Defense personnel in determining radioactive contamination levels that may result from an enemy attack or other nuclear disaster.

Instrument accuracy on any of its three ranges is within ±15% of the true dose rate from CO^{60} gamma radiation. This accuracy is maintained throughout a temperature range of —20° F to +125° F, relative humidities to 100% and at altitudes from sea level to 25,000 feet.

2.2 SENSING ELEMENT:

The detecting element in the CD V-720 is an hermetically sealed ionization chamber. This chamber is located in the lower front portion of the instrument, as shown in Figure 2, to make the instrument equally sensitive to radiation from the bottom and front. The chamber has an aluminum window on the bottom to permit detection of beta particles. The bottom of the instrument case contains a sliding shield to permit discrimination

against beta particles if desired. The ionization chamber is hermetically sealed to eliminate changes in sensitivity due to changes in air pressure resulting from altitude changes, temperature changes, and moisture effects.

2.3 ELECTRONIC CIRCUITRY:

All electrical components which make up the circuitry are fastened to a printed circuit board. The circuitry serves to measure the minute current from the ionization chamber which indicates the presence of ionizing radiation. The high impedance components are housed in a gasketed light-tight metallic enclosure for protection and shielding.

2.4 BATTERIES:

The CD V-720 is powered by two "D" size flashlight cells (NEDA 13). The batteries will operate the instrument continuously for over 150 hours and much longer on an intermittent basis.

2.5 METER AND CONTROLS:

The CD V-720 uses a ruggedized, sealed meter to meet the instrument requirements for water-tightness, shock and vibration resistance. Two controls are provided. One control is a range switch which turns the instrument on, checks its operation and serves to select the proper range. The second is a zero control which is used to adjust the instrument to assure proper reading.

2.6 PHYSICAL FEATURES:

The instrument is housed in a die cast aluminum case with a cast canti-lever handle keyed and bolted in place. Carrying strap hooks and the zero control guard are permanently molded in. The nameplate and control knob information is indelibly engraved into the case top. Two snap type pull catches serve to fasten the bottom of the case to the top. Water tightness is ensured by the closed cellular sponge rubber gasket between the case top and bottom and the triple squeegee or lip-action gasket between case bottom and ion chamber. This latter gasket also permits ready removal of the case bottom. The instrument is operable with the case bottom removed. The batteries are housed in a high-impact resistant plastic case which cannot be corroded by leaking battery fluids. The battery contacts are readily replaceable without tools to facilitate cleaning or replacement. The battery box is designed to be mechanically selective so that batteries cannot be inserted backwards. The instrument is approximately 9" long, 4½" wide and 4" high, excluding the handle. The instrument weight is 3¾ pounds and will float in water.

3. THEORY OF OPERATION

3.1 IONIZATION CHAMBER:

The detecting element of the CD V-720 is an hermetically sealed air filled ionization chamber. It consists of a cylindrical container of aluminum called the shell and a thin aluminum disc called the collector, located in the center of the shell. The shell is the positive electrode and the collector the negative electrode. The collector is insulated from the shell by an extremely high resistance feed-thru insulator. A voltage, called the collecting voltage, is applied between these two chamber electrodes. This makes the shell approximately 50 volts positive with respect to the collector. See Figure 3. Radiation, passing through the chamber, causes ionization of the air molecules contained within the chamber. These charged particles or ions are attracted

to the chamber electrode having the opposite charge; i.e., positive ions move toward the center electrode of the chamber and negative ions move toward the shell.

The arrival of these ions at the chamber electrode constitutes a current which is proportional to the number of ions collected. Since the number of ions created is proportional to the radiation intensity, this ionization current is proportional to the radiation intensity in the ionization chamber.

3.2 INPUT CIRCUIT:

The ionization current is extremely small—about 0.00007 microamperes at 5 r/hr which is full scale on the most sensitive range. It flows through a very high resistance (8,000 megohms) called a "Hi-Meg" connected to the collector of the ionization chamber as shown in Figure 3. This ionization current (0.00007 microamperes when the meter reads its full scale of 5 r/hr) develops a voltage drop of about 0.6 volts across the "Hi-Meg" resistor with the polarity as shown.

The voltage developed is applied to the grid of a vacuum tube for amplification. Any of the minute ionization current flowing to the grid of the tube instead of through the "Hi-Meg" resistor would result in amplification of only a portion of the signal. A special vacuum tube called an electrometer tube capable of amplifying voltages at extremely small grid currents is used to prevent this error. This tube is connected as a triode as shown in Figure 3.

3.3 MEASURING CIRCUIT:

In order to permit zeroing the instrument in a radiation field, a section of the range switch is used to short circuit the "Hi-Meg" resistor and prevent any ionization signal from being sensed by the input circuit on the "ZERO" position. A "ZERO" control is located on the top of the instrument for balancing out static plate current. This balancing is accomplished by changing the grid bias on the electrometer tube by means of the potentiometer, R7.

The measurement of the grid voltage of the electrometer tube is accomplished by metering the change in plate current directly. The static plate current is cancelled by running a reverse current, supplied by the filament battery BT2, through the meter. The magnitude of this current is fixed by the bucking resistor R9.

Sensitivity of the instrument is changed by switching "Hi-Meg" resistors, which is accomplished by the range switch.

3.4 POWER SUPPLY CIRCUIT:

Three separate d.c. voltages are required by the measuring circuit as shown in Figure 3. These are the plate voltage supply of 8 volts, the grid bias supply of —4 volts and the ion chamber collecting voltage of 50 volts.

All of these voltages are obtained from a transistor blocking oscillator circuit. The transistor Q1 permits current from BT1 to build up in the primary winding of the transformer. This current increases until the core of the specially designed transformer is saturated. When saturation is reached, the transistor is cut off by its base biasing (Sec. No. 1) and the rapid collapse in primary current (and flux) results in a voltage pulse of about 15 volts at the primary winding. This voltage pulse is rectified by CR1 and clipped or regulated at 8 volts by the zener' diode CR2, to provide the current plate supply voltage.

The above regulating or clipping action carries over to the secondary

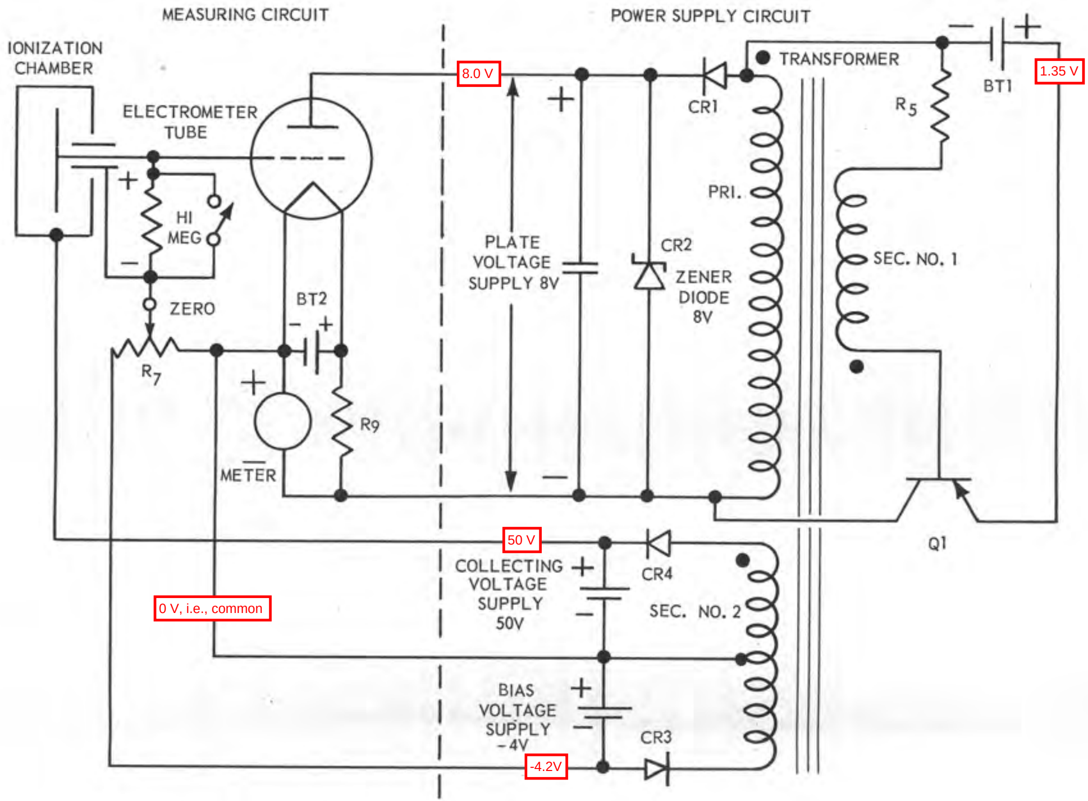


Figure 3. Simplified Schematic Circuit Diagram

winding No. 2 by reflection where the clipped voltage pulse is rectified by CR3 for the —4 volt bias supply voltage and by CR4 for the 50 volt ion chamber collecting voltage.

The oscillator circuit design with its saturating transformer utilizes the transistor as an on-off switch and assures independence of transistor parameter changes. This feature together with the zener regulator results in very low zero drift with temperature changes and battery life.

4. INSTALLATION

4.1 INSPECTION:

The instrument is shipped with batteries and carrying strap removed from the instrument and packed separately. Inspect the batteries for possible

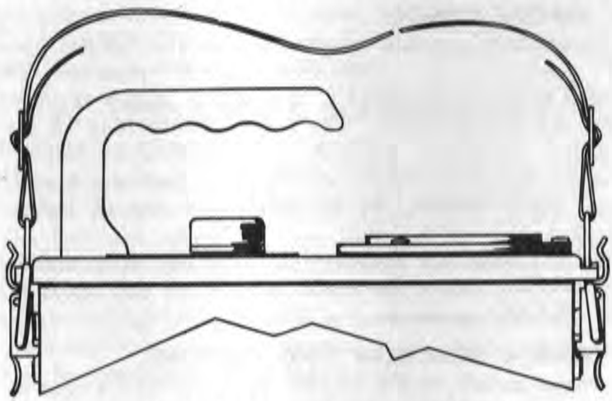


Figure 4. Method of Attaching Shoulder Straps

leakage before installation. Do not install leaking batteries. Inspect the instrument for damage in shipment. If damage is apparent the batteries should not be installed, thus preventing further damage due to possible short circuits.

4.2 BATTERY INSTALLATION:

Open the instrument by snapping open the pull catch at each end of the case and separating the top from the case bottom. This exposes the battery box and battery retainer clip as shown in Figure 2. Remove the retainer clip by squeezing its ends until it can be pulled out of the slots in the battery box. Insert the batteries in the battery box observing the indicated polarity. (The battery box is designed to be mechanically selective so that the batteries cannot be inserted with reversed polarity). Replace the battery retainer clip. Close the case by sliding the ion chamber back into its well. Align the top with the case bottom and squeeze together gently. Snap the pull catches closed.

4.3 SHOULDER STRAP INSTALLATION:

The carrying strap and two carrying strap slides and clips are packed separately. They are affixed to the cast-in carrying strap loops in the end of the case as shown in Figure 4, and the length is adjusted to suit the operator.

5. OPERATION

5.1 ADJUSTMENTS AND READINGS:

There are three simple basic steps recommended for proper operation of the CD V-720. They are described as follows:

Step 1. ZERO ADJUST.

Turn the instrument on by turning the range switch from "OFF" to the "ZERO" position. Wait about a minute to allow the electrometer tube to warm up, then orient the "ZERO" control until the meter needle indicates zero on the meter.

CAUTION

> If the instrument is not zeroed properly, readings taken on any of the three ranges will be erroneous. The drift will be in an upscale direction at a very slow rate.

Step 2. CIRCUIT CHECK.

Turn the range switch counter clockwise from the "ZERO" position through the "OFF" position to the "CIRCUIT CHECK" position. This position is spring-loaded to return to "OFF". The range switch must be held in this position for the circuit check. The meter should read in the red outlined section labeled "CIRCUIT CHECK". If it does not, either the batteries are low or trouble exists in the circuit. See Sections 6 and 8 for proper procedures. Make certain the instrument is zeroed before making the circuit check.

Low or dead batteries are indicated by inability to zero the instrument or by a meter reading below the check band when the range switch is in the "CIRCUIT CHECK" position.

Step 3. RANGE SELECTION AND READING.

Turn the range switch to the "X100, X10, or X1" range as necessary to obtain an upscale reading on the meter.

The meter reading observed must be multiplied by the factor indicated by the position of the range switch to obtain the radiation dose rate in roentgens per hour (r/hr).

EXAMPLE:

METER READING	3.8
RANGE	X100
INTENSITY OF RADIATION	380 r/hr

READINGS SHOULD NOT BE TAKEN WITH POINTER INDICATING IN LOWER 10% OF SCALE (SHADED IN ILLUSTRATION). TURN TO NEXT MOST SENSITIVE RANGE UNTIL POINTER INDICATES IN UPPER 90% OF SCALE (UNSHADED).

Another example is a meter reading of 2.4 on the "X10" range which indicates a dose rate of 24 roentgens per hour while the same reading obtained with the instrument turned to the "X100" range corresponds to 240 r/hr.

A sliding beta window shutter is provided in the bottom of the instrument. This shutter has three indexed positions.

1. Completely closed—The shutter is in its most forward position and covers the beta window of the chamber.
2. 25% open—The shutter exposes 25% of the beta window to radiation from the bottom of the instrument.

3. Completely open—The shutter is in its most rearward position and exposes the complete beta window of the chamber.

For the measurement of gamma radiation dose rates only, the shutter should be in the completely closed position.

If beta radiation plus gamma radiation is to be measured, the shutter should be in the completely open or 25% open position. Under these conditions the instrument will give a reading which is the sum of the gamma and beta radiation levels. To determine the beta level alone the reading with the shutter completely closed (gamma dose rate only) should be subtracted from the reading with the shutter in an open position.

It is recommended that the beta shutter be kept closed as much as possible in order to protect the 0.006 inch thick aluminum beta window from damage.

It is also recommended that the instrument be kept turned off, except for periods where frequent readings are required, in order to conserve battery life. The "ZERO" or "CIRCUIT CHECK" may be performed at any time, whether the instrument is in a radiation field or not.

6. OPERATOR'S MAINTENANCE

6.1 BATTERY REPLACEMENT:

Battery replacement is indicated whenever the instrument can no longer be zeroed or when the meter indicates below the "CIRCUIT CHECK" band. To replace the batteries, snap open the pull catches and separate the two halves of the instrument. Remove the batteries and install new batteries as indicated in Parag. 4.2 BATTERY INSTALLATION. If a voltmeter is available the batteries may be checked in accordance with Parag. 8.3. Batteries should be removed from the instrument and stored separately if the instrument is to be stored more than a few weeks.

6.2 CLEANING:

WARNING

> Do not use cleaning solvents on the plastic parts. To clean the case, use soap and water. If the batteries have leaked, remove the case bottom and fill with warm water. The battery spillage will be loosened in a short while and can be rinsed out. Be careful not to soak off the circuit diagram or the CD decal.

7. PREVENTIVE MAINTENANCE

7.1 PREVENTIVE MAINTENANCE:

It is recommended that preventive maintenance procedures be carried out once a month when the instrument is in use, and about once every six months when the instrument is in storage.

Preventive Maintenance should be carried out as follows:

a. Remove the batteries, clean battery contacts and battery terminals if necessary and remove any corrosion present.
b. Replace the batteries making certain that all batteries make good contact and exceed minimum voltage.
c. Perform the operation indicated in Section 5, ZERO and CIRCUIT CHECK.

Batteries should be removed from the instrument and stored separately if the instrument is to be stored more than a few weeks.

8. CORRECTIVE MAINTENANCE

WARNING

Calibration should be attempted only by personnel trained in the use of radioactive isotope sources.

8.1 CALIBRATION:

The CD V-720 is calibrated by being placed in a gamma radiation field of known dose rate. Such fields are most commonly produced by using a radioactive material such as radium or Cobalt^{60}. As an example a 1 curie radium source will produce a radiation dose rate of 4 r/hr. at a distance of 18.1 inches. The CD V-720 should read this dose rate when so positioned with the center of the ion chamber at this distance. If it does not, the instrument should be recalibrated. This is accomplished by removing it from its case and adjusting the individual "CAL" controls for the corresponding ranges so that the proper reading is indicated on the meter. The distance from the center of the CD V-720 ionization chamber to the calibrating source should be at least 12 inches to obtain reasonable geometry (reasonably uniform radiation intensity over the volume of the ionization chamber).

If necessary to remove the instrument from its case to adjust the "CAL" controls, the instrument must be replaced in the case to obtain a correct reading.

8.2 DISASSEMBLY FOR CORRECTIVE MAINTENANCE:

a. Release the snap action catches and remove the instrument from the case bottom.

b. Remove the retaining clip and batteries from the battery box.

c. Remove the four screws which secure the battery box to the instrument top. Swing the battery box away from the circuit board. Wiring between the battery box and the circuit board prevents complete separation of the battery box.

d. Remove the four screws and spacers which secure the chamber to the instrument top.
Note: At this point the instrument (with batteries) will operate on ZERO and CIRCUIT CHECK ranges and the circuit board is completely exposed for trouble shooting.

e. Remove the meter nuts.

f. Remove the knob from the ZERO control. It is not necessary to remove the range switch knob.

g. Remove the circuit board. This is most easily accomplished by pressing on the ZERO control shaft and applying a slight pressure at the meter studs.

h. Remove the nuts, washers, and lockwashers from the top of the circuit shield box.

i. Remove the circuit shield box. The instrument is now completely disassembled.

Reassembly of the instrument is the reverse of the disassembly procedure.

CAUTION

Before beginning reassembly make certain the range switch and *both* switch wafers are oriented in the *OFF* position.

8.3 TROUBLE SHOOTING:

The majority of the electrical components of the CD V-720 are standard parts familiar to electronic technicians and are readily checked by conventional means. The electrometer tube, the "Hi-Meg" resistors, the ion chamber insulator and the ceramic switch section are the only components requiring special precaution. These components are all part of the high resistance input circuit. THE INSULATING PORTIONS OF THESE FOUR COMPONENTS SHOULD NOT BE HANDLED. They should be touched only with clean tools when repairs are made. If surface leakage on any of these items is suspected, cleaning with clean alcohol using a clean camel hair brush is recommended. Avoid solder flux splattering on these components when repairs are made.

All batteries as well as the measuring circuit are checked by the "CIRCUIT CHECK". If trouble exists, batteries should be checked with any voltmeter having a sensitivity of 1000 ohms/volt or more. The "D" cells, BT1 and BT2, should read higher than 1.2 volts.

Circuit malfunctions may be traced with the aid of the schematic circuit diagram, Figure 5. Voltage measurements shown on this diagram are measured with respect to point* and are those obtained with a voltmeter having a sensitivity of 20,000 ohms per volt. Such voltage checks should be taken with the instrument range switch turned to the "ZERO" range and with the zero control adjusted so that the instrument reads zero.

The following troubles and corrective action are presented as an aid to trouble shooting.

TROUBLE SHOOTING CHART

Trouble and Cause	*Corrective Action*
NO READING	
Filament Battery Low	Replace the Battery
Corroded Battery Contacts	Clean or Replace the Contacts
Meter Damaged	Replace Meter
Chamber Damaged	Replace Chamber
Open Connection	Inspect Solder Joints
METER WILL NOT ZERO (Reads Upscale)	
Transformer Defective	Replace Transformer
METER WILL NOT ZERO (Reads Downscale)	
Power Supply Battery Low	Replace Battery
Corroded Battery Contacts	Clean or Replace Contacts
Defective Tube	Check Tube Filament
Transformer Defective (Transformer does not "Sing")	Replace Transformer
INSTRUMENT READS LOW	
Calibration Control Disturbed	Check Calibration
Defective Tube	Replace Tube
Meter Damaged	Replace Meter
Defective Chamber	Replace Chamber
Dirty High Resistance Components	Clean High Resistance Components
INSTRUMENT READS HIGH	
Calibration Control Disturbed	Check Calibration
Damaged "Hi-Meg" Resistor	Replace "Hi-Meg" Resistor
Dirty High Resistance Components	Clean High Resistance Components

Blue letters correspond to CD V-717 1 service manual as closely as possible (pages 10-24, -25, -26). I added U, V, W, and X.

This graphic means 8.0 V on 10V scale on 20,000 Ω/V meter with switch = ZERO and instrument zeroed. Relative to point * (easiest access is the junction of C2 and C3). All values ±20%.

Of course, "on 10V scale" is less relevant if the DMM supports auto ranging. Also, DMMs commonly have an input impedance of 10 MΩ when measuring DC Volts; this more than satisfies the "20,000 Ω/V meter" requirement , e.g., 10 MΩ / 50 V = 200,000 Ω/V.

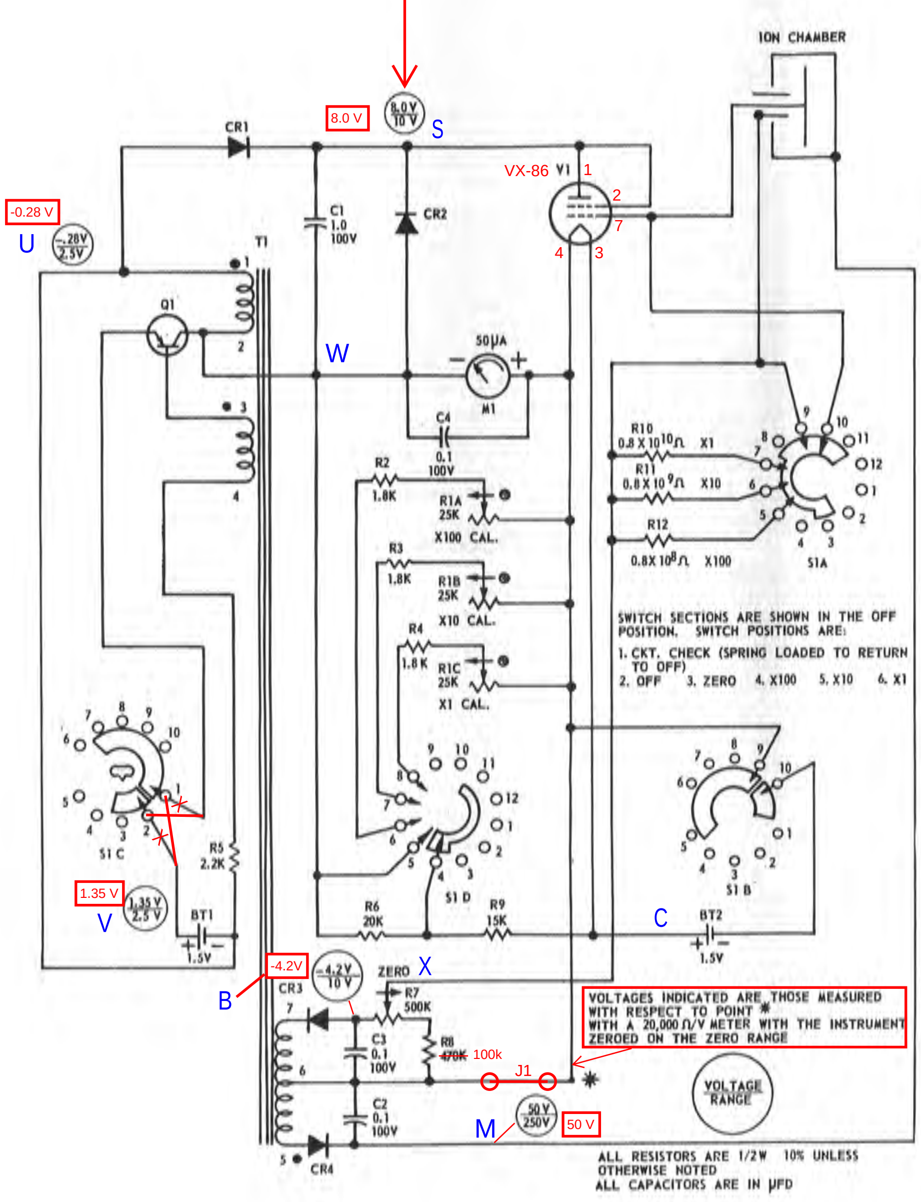


Figure 5. Schematic Circuit Diagram

9. REPLACEABLE PARTS LIST

9.1 Electrical Components

Circuit Symbol	Description	Function	Manufacturer	Mfg. Part No.	Victoreen Part No.	Quantity Per Equipment	*Quantity for Maintenance
C1	Capacitor: 1 ufd; 100V	Filter Capacitor	John E. Fast	8FM196M	21-89	1	1
C2, C3	Capacitor: 0.1 ufd; 100V	Filter Capacitor	John E. Fast	F207B104M1	21-205	2	4
C4	Capacitor: 0.1 ufd; 100V	By-Pass Capacitor	John E. Fast	8FM165E	21-195	1	1
CR1	Diode: PA305A (or equiv.)	Rectifier	Computer Diode	CODI 232	489-18	2	5
CR2	Diode: Zener 8V	Regulator	Pacific Semi-Conductor, Inc.	PS6464	52-28	1	3
CR3	Same as CR1	———	———	———	———	———	———
CR4	Diode:	H. V. Rectifier	Computer Diode	CODI 243	52-30	1	5
M1	Meter Assembly: 0-50 ua d. c.	Indicator	Victoreen	720-110	720-110	1	5
Q1	Transistor	Pwr. Supply Trans.	Tung-Sol	TS-601	23-18	1	2
R1A	Potentiometer: 25K-25K-25K ½W 20%	X100 Calibration	CTS of Ashville	X-53	22-24	1	1
R1B	Section of R1	X10 Calibration	———	———	———	———	———
R1C	Section of R1	X1 Calibration	———	———	———	———	———
brn gry red sil R2	Resistor: 1.8K; ½W; 10%	X100 Calibration	International Resistance Co.	GBT-½	185-347	3	3
R3	Same as R2	X10 Calibration	———	———	———	———	———
R4	Same as R2	X1 Calibration	———	———	———	———	———
red red red sil R5	Resistor: 2.2K; ½W; 10%	Transistor Bias	International	GBT-½	185-657	1	1
red blk org sil R6	Resistor: 20K; ½W; 5%	Circuit Check	International	GBT-½	185-135	1	1
R7	Potentiometer: 500K; ½W; 10%	Zero Adjust	Centralab Div. Globe Union	BA811-3352	22-25	1	1
brn blk yel sil R8	Resistor: ~~470K~~ 100k (confirmed); ½W; 10%	Voltage Divider	International Resistance Co.	GBT-½ ???	185-259 ???	1	1

*Quantity of plant and field maintenance supply parts based on five instruments for one year of operation.

9.1 Electrical Components (cont'd)

	Circuit Symbol	Description	Function	Manufacturer	Mfg. Part No.	Victoreen Part No.	Quantity Per Equipment	*Quantity for Maintenance
brn grn org sil	R9	Resistor: 15K; ½W; 10%	Plate Current Bias	International Resistance Co.	GBT-½	185-393	1	1
??? blk 8 000 000 000 = 8GΩ	R10	Resistor: Hi-Meg 0.8×10^{10} ohms; ½W; 10%	Grid Resistor—X1	Victoreen	185-1415	185-1415	1	1
grn blk 800 000 000 = 800MΩ	R11	Resistor: Hi-Meg 0.8×10^{9} ohms; ½W; 10%	Grid Resistor—X10	Victoreen	185-1414	185-1414	1	1
org blk 80 000 000 = 80MΩ	R12	Resistor: Hi-Meg 0.8×10^{8} ohms; ½W; 10%	Grid Resistor—X100	Victoreen	185-1413	185-1413	1	1
	S1A	Ceramic Wafer	Range Switch—High Impedance Ckt.	Oak Mfg. Co.	214029-JC	720-116	1	2
	S1B	Section of S1A	Range Switch—High Impedance Ckt.	—	—	—	—	—
	S1C	Phenolic Wafer	Range Switch—Low Impedance Ckt.	Oak Mfg. Co.	214030-J	720-166	1	1
	S1D	Section of S1C	Range Switch—Low Impedance Ckt.	—	—	—	—	—
	T1	Transformer: Pulse Ass'y	Pwr. Supply Trans.	Victoreen	720-104	720-104	1	1
	V1	Electrometer Tube VX-86	Elect. Amplifying	Victoreen	35-134	35-134	1	5
		Ionization Chamber	Detector	Victoreen	720-135	720-135	1	5
	BT1	Battery: 1.5V NEDA Type 13	Pwr. Supply Battery	Union Carbide Consumers Co.	950	263-17	2	40
	BT2	Same as BT1	Filament Battery	—	—	—	—	—

*Quantity of field and plant maintenance supply parts based on five instruments for one year.

9.2 Mechanical Components

Description	Function	Manufacturer	Mfg. Part No.	Victoreen Part No.	Quantity Per Equipment	*Quantity for Maintenance
Strap Buckle	Carrying Strap Length Adjustment	Waterbury Buckle Co.	807 5047	710-44	2	4
Strap Fastener	Attaches Shoulder Strap	Victoreen	700-82	700-82	2	4
Shoulder Strap	Carrying Strap	Victoreen	700-81	700-81	1	2
Case Bottom Ass'y	Bottom of Inst. Case	Victoreen	720-130	720-130	1	2
Gasket	Chamber-Case Bottom Seal	Victoreen	720-158	720-158	1	10
Knob	Zero Adjust	Harry Davies Molding Co.	1450 AC Black	720-107	1	5
Battery Retainer Clip	Holds Batteries in Box	Victoreen	720-121	720-121	1	3
Battery Contact	Elect. Connections to Batt.	Victoreen	700-68	700-68	4	15
Battery Box	Holds Batteries	Victoreen	700-66	700-66	1	3
"O" Ring Shaft Seal	Zero Adj. Shaft Seal, Switch Index	Parker Appliance Co.	5427-1	710-42	2	6
Tube Socket	Holds Electrometer Tube	Elco Mfg. Co.	805BC	720-122	1	2
Knob, Range	Selector Switch	Harry Davies Molding Co.	1500K	710-85	1	2
Meter Gasket	Cast Top-Meter Seal	Victoreen	700-63	700-63	1	5
Switch Index	Positions Range Switch	Oak Mfg. Co.	206722-J	720-106	1	3
"O" Ring	Handle—Case Top Seal	Parker Appliance Co.	2-9	46-25	1	3
Case Gasket	Case Top-Case Bottom Seal	Victoreen	720-157	720-157	1	10
Handle	Inst. Carrying Handle	Victoreen	720-114	720-114	1	3
Case Top	Top of Instrument Case	Victoreen	720-111	720-111	1	3
Instruction Manual	Operating & Maintenance Instructions	Victoreen	720-101	720-101	2	10
Spacer	Ion Chamber to Ckt. Brd. Spacer	Victoreen	720-175	720-175	4	10
Spacer	Guard Ring to Ckt. Brd. Spacer	Victoreen	720-117	720-117	1	5
Switch Drive Shaft	Connects Switch Index to Switch Wafers	Victoreen	720-126	720-126	1	3
Shield Box	Shields High Impedance Ckt.	Victoreen	720-123	720-123	1	1
Grommet	Holds Switch Drive Shaft in Shield Box	Philpott Rubber Co.	GB-225	373-75	1	1
Chamber Contact Spring	Connects Chamber Center Electrode to Elect. Tube Grid	Victoreen	720-153	720-153	1	2

*Quantity of plant and field maintenance supply parts based on five instruments for one year of operation.

CENTRALAB DIVISION, GLOBE UNION, 900 East Keefe Avenue, Milwaukee, Wisconsin

COMPUTER DIODE CORPORATION, 250 Garibaldi Avenue, Lodi, New Jersey

CTS OF ASHVILLE, 1142 Beardsley Avenue, Elkhart, Indiana

ELCO CORPORATION, "M" Street, Philadelphia, Pennsylvania

HARRY DAVIES MOLDING COMPANY, 1428 North Wells Street, Chicago 10, Illinois

JOHN E. FAST COMPANY, 3580 North Elston Avenue, Chicago 18, Illinois

INTERNATIONAL RESISTANCE COMPANY, 401 North Broad Street, Philadelphia, Pennsylvania

OAK MANUFACTURING COMPANY, 1260 North Clybourn, Chicago, Illinois

PACIFIC SEMICONDUCTORS, INC., 10451 West Jefferson Boulevard, Culver City, California

PARKER APPLIANCE COMPANY, 17325 Euclid Avenue, Cleveland 12, Ohio

PHILPOTT RUBBER COMPANY, 2077 East 30th Street, Cleveland 15, Ohio

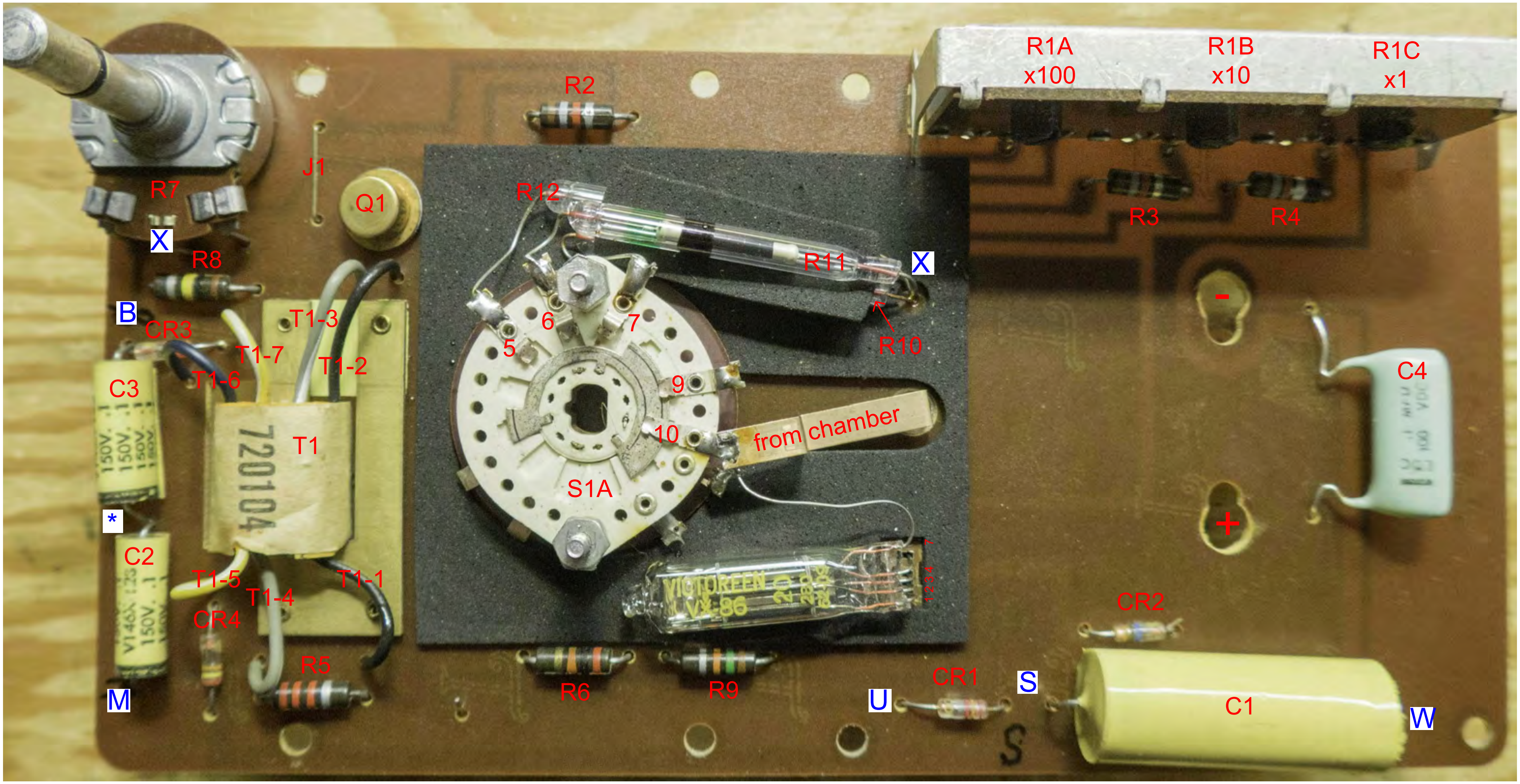
TUNG-SOL ELECTRIC, INC., 1 Summer Avenue, Newark, New Jersey

UNION CARBIDE CONSUMERS COMPANY., 30 East 42nd Street, New York, New York

VICTOREEN INSTRUMENT COMPANY, 5806 Hough Avenue, Cleveland 3, Ohio

WATERBURY BUCKLE COMPANY, 862 South Main Street, Waterbury 20, Connecticut

circuit board - top



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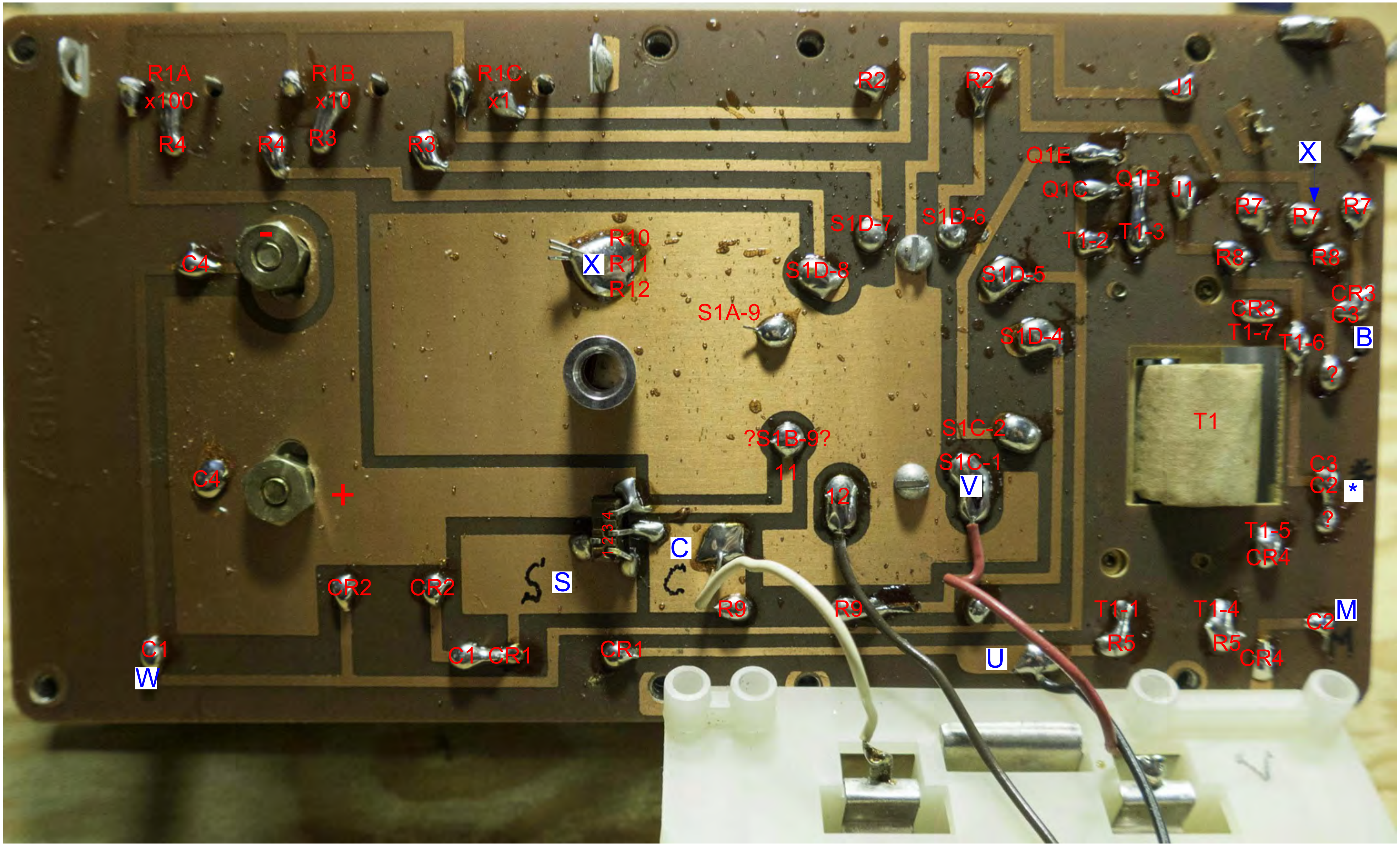
circuit board - bottom



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Victoreen CD V-720 3A serial 17464

symptoms of defect (reads high on all ranges)

X100
5 R/hr (0.05 x 100)

X10
4 R/hr (0.4x10)

X1
3.05 R/hr (3.05 x 1)

Victoreen CD V-720 3A serial 17464 measurements

Component Measurements

Remove batteries. Values ±20% except as noted.

Component	Points	Range Switch Position	spec	measured
C1		OFF	1 uF 100 V	
C2		OFF	0.1 uF 100V	
C3		OFF	0.1 uF 100V	
C4		OFF	0.1 uF 100V	
CR1		OFF	diode	
CR2		OFF	Zener 8V	
CR3		OFF	diode	
CR4		OFF	diode	
R2 (brn gry red)		OFF	1.8 kΩ	1.824 kΩ
R3 (brn gry red)		OFF	1.8 kΩ	1.887 kΩ
R4 (brn gry red)		OFF	1.8 kΩ	1.841 kΩ
R5 (red red red)		OFF	2.2 kΩ	1.066 kΩ in parallel with T1
R6 (red blk org)		OFF	20 kΩ	23.18 kΩ
R7 (ZERO)		OFF	500 kΩ pot	
R8 (brn blk yel)		OFF	100 kΩ	103.4 kΩ
R9 (brn grn org)		OFF	15 kΩ	16.6 kΩ
R10 (X1)		OFF	8.0 GΩ ±10%	6.01 GΩ by Keysight U1461A (IRT mode) out of spec
R11 (X10)		OFF	0.8 GΩ ±10%	0.746 GΩ by Keysight U1461A (IRT mode)
R12 (X100)		OFF	80 MΩ ±10%	62.91 MΩ by Keysight U1461A (IRT mode) 63.3 MΩ by Fluke 289 63.7 MΩ by Keysight 34461A out of spec
V1		OFF	80 - 150 Ω[1,3] 110 Ω[2,3]	36.1 Ω in circuit (out of spec) 35.9 Ω out of circuit (out of spec) by Fluke 116 safe: 0.6 mA < 10 mA (see page 3: 1.4)

[1] service 717-1 p. 10-26 and service 715-1B p. 9-18 [2] service 720-2 p. 12-18 and service 720-3 p. 13-18

[3] V1 filament resistance specs are from VX-86 circuits different from the 720 3A, for which no spec is provided. Other circuit components are in play in all of the circuits, including the 720 3A, so the validity of the spec is uncertain.

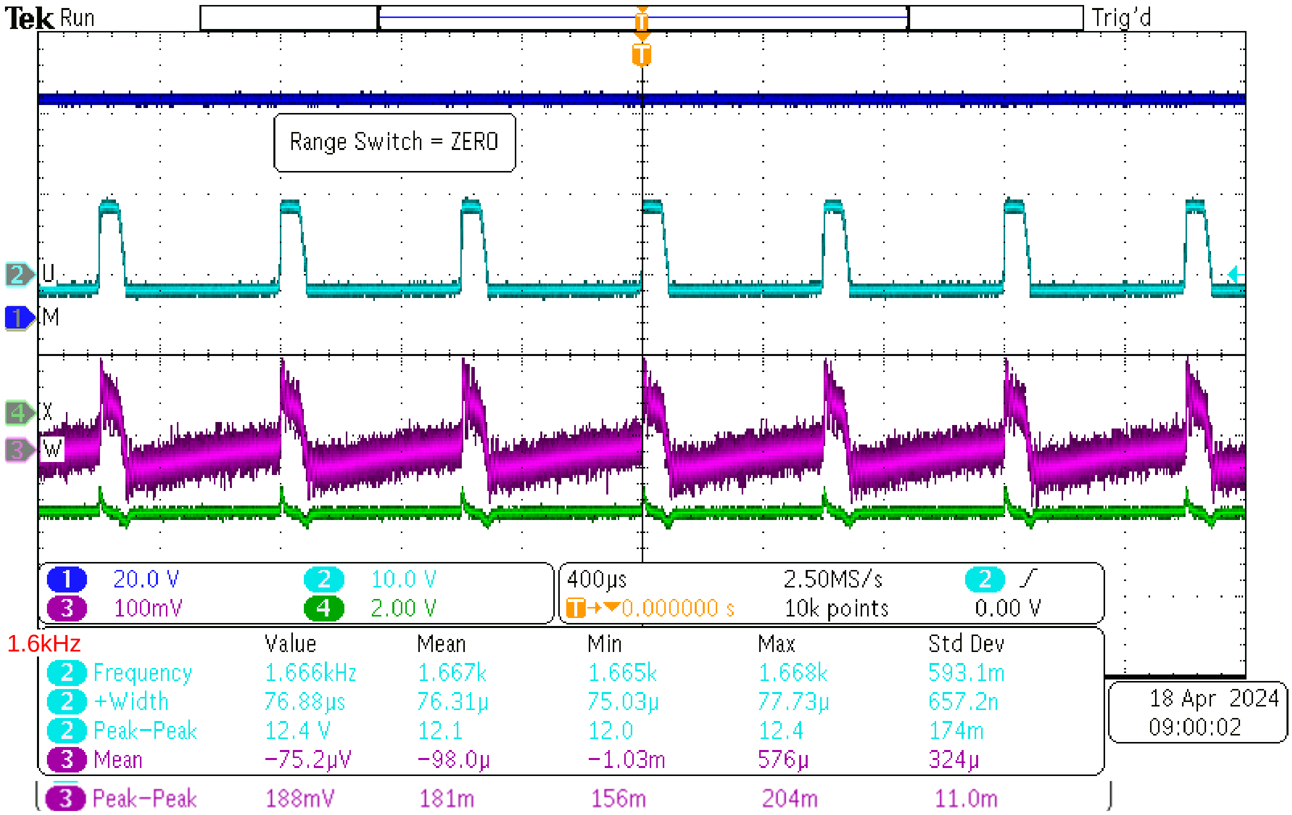
Voltage Measurements

Voltages measured with respect to point * with instrument correctly zeroed on ZERO range. All values ±20%.

Point	spec V	measured V (Fluke 116)	comment
M	50 V	55.40 V	
S	8.0 V	7.86 V	
B	-4.2 V	-4.50 V	
C	1.5 V	1.53 V	
U	-0.28 V	-0.12 V	Seems out of spec but signal is a pulse. See "value of U" page for scope measurements
V	1.35 V	1.41 V	

oscilloscope on points M, U, W, X (annotated next to channel labels)

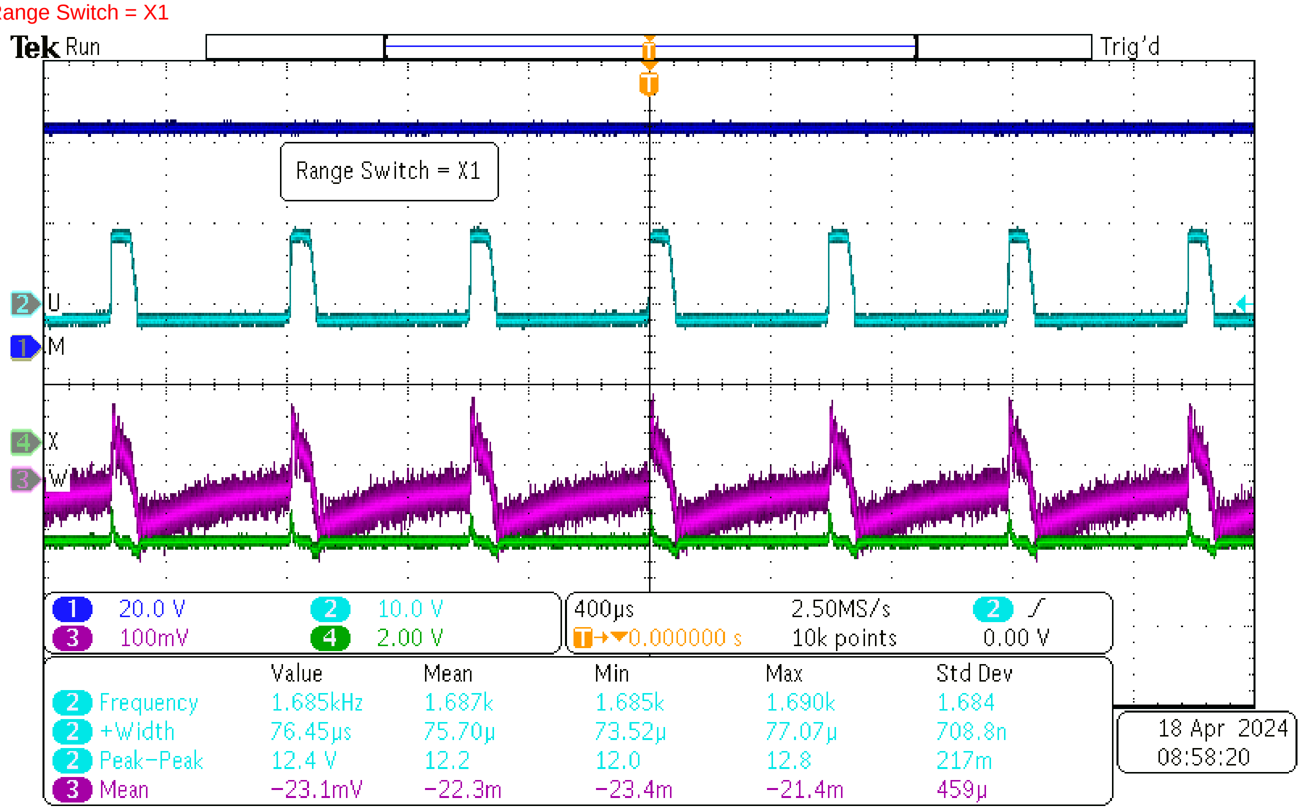
Range Switch = ZERO



slight hum -> 1.6kHz

Measure	Units	Current	Mean	Min	Max	Std.Dev	Count	Description
FREQUENCY(CH2(U))	Hz	1.6659k	1.6668k	1.6653k	1.6681k	635.4668m	37	
PWIDTH(CH2(U))	s	76.85µ	76.3521µ	75.0333µ	77.7333µ	640.1417n	37	
PK2PK(CH2(U))	V	12.4	12.122	12	12.4	186.6555m	37	
MEAN(CH3(W))	V	-946.694µ	-158.881µ	-1.0299m	575.6576µ	372.9016µ	37	

Range Switch = X1

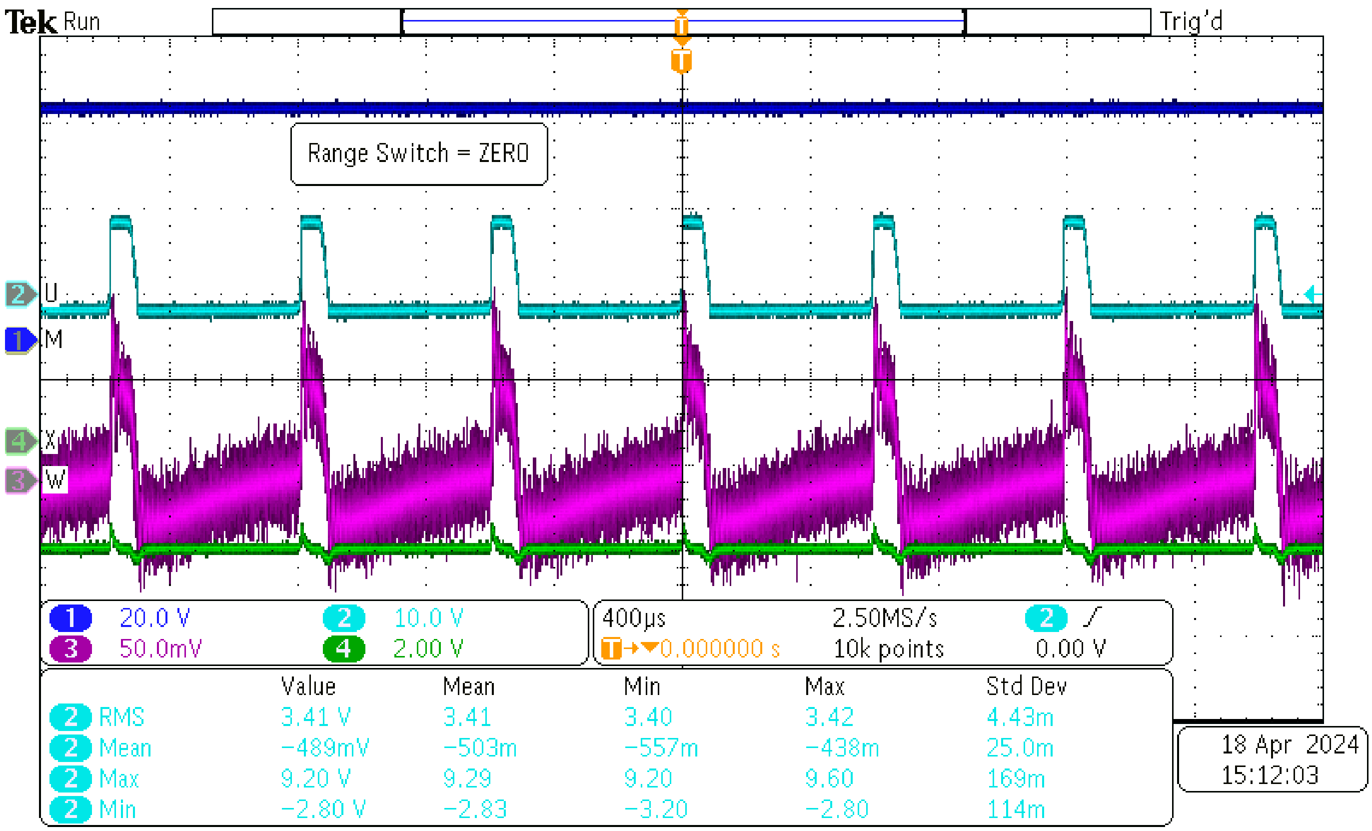


Measure	Units	Current	Mean	Min	Max	Std.Dev	Count	Description
FREQUENCY(CH2(U))	Hz	1.6846k	1.6871k	1.6844k	1.6903k	1.7669	56	
PWIDTH(CH2(U))	s	76.8µ	75.7221µ	73.52µ	77.0667µ	708.7246n	57	
PK2PK(CH2(U))	V	12.4	12.1854	12	12.8	237.7507m	57	
MEAN(CH3(W))	V	-22.5995m	-22.243m	-23.3553m	-21.3763m	454.8226µ	57	

As expected, note that the Mean for CH3 (W) changes between Range Switch = ZERO versus X1. It might be this value which causes the high reading.

value of U (RMS, Mean, Max, Min)

Range Switch = ZERO



Measure	Units	Current	Mean	Min	Max	Std.Dev	Count	Description
RMS(CH2(U))	V	3.4119	3.4103	3.4005	3.4238	4.9184m	48	
MEAN(CH2(U))	V	-501.730m	-504.033m	-569.437m	-438.223m	26.4163m	48	
MAXIMUM(CH2(U))	V	9.2	9.2908	9.2	9.6	167.719m	49	
MINIMUM(CH2(U))	V	-3.2	-2.853	-3.2	-2.8	137.3137m	49	

The Mean of the MEAN (-0.5 V) is probably best for comparison to the spec of -0.28 V given that the spec is from the era of analog meters. Regardless, given the nature of the waveform and the fact that all boost voltages are within spec, U seems acceptable rather than the out-of-spec -0.12 V indicated by the Fluke 116 DMM (on the "measurements" page).

Also of note is the Mean of the MAX (about 9.3 V) in comparison to the expected "about 15 V" mentioned in section 3.4 on page 5.

Victoreen CD V-720 3A serial 17464
analysis and conclusion

o V1 (VX-86) filament resistance is out of spec but the spec itself is uncertain.

o Hi-Meg resistors R10 and R12 are out of spec.

o The fact that the high readings are relatively consistent (5, 4, 3) given the accuracy of the different ranges tends to indicate that that the problem is in the shared circuit elements rather than the range-specific components.

> o Therefore, R10 and R12 being out of spec might not be an issue; perhaps the calibration adjustments (R4, R2) are sufficient to compensate.

o After cleaning V1, R10, R11, and R12 with alcohol:

> o all ranges indicated zero when the ionization chamber was not installed.
>
>> o Is this an indication that V1 might be OK despite the out-of-spec filament resistance? Is the ionization chamber the cause of the problem?
>
> o with the ionization chamber installed, the X1 range now indicates 1.5 R/hr. While this is less than the 3.05 R/hr shown on the "17464 symptoms" page, it is close to the reading obtained a few days earlier.
>
> o after reassembling the unit, I realized that I should have cleaned the path from the ionization chamber to S1A-10. This path consists of a needle attached to the ionization chamber and a flat, sprung, brass (?) strip ("Chamber Contact Spring", 720-153). And the aluminum tunnel which connects the chamber to S1A-9 (no part number or description but it stands out in the "circuit board – bottom" image). Clean S1A? Clean the large rubber gasket ("Chamber-Case Bottom Seal", 720-158)?

o The boost converter seems OK, i.e., voltages 50 V, -4.5 V, 8 V are within spec and the oscilloscope page shows triggering.

> o So Q1 is probably OK.
>
> o Would it be worth unsoldering one end of each electrolytic and measuring with DER EE DE-5000?
>
> o The oscilloscope page shows W (CH3) is noisy. Test C4?

o I suspect the issue is corruption of the high impedance circuitry as described in section 1.1 on page 3; even if fixed I suspect the problem would quickly recur because the design/implementation is too fragile. Or perhaps recalibration is required after 63 years.

o I left my unit as is because the fix was not obvious to me and I have no way to calibrate the unit if parts are replaced. Plus finding component specs (e.g. for Q1) and replacement parts (e.g., V1) would be iffy. And the money would be better spent on newer technology (I like my new GQ GMC-800; purchased 2024.04). Plus I have a working 715 A1 and a working 717 1, which replaced the 720 series; both add a X0.1 range.